The Demand for Money in Cote d'Ivoire: Evidence from the Cointegration Test.

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Abstract

This paper demonstrates that there is a long run equilibrium relationship between money supply (M_1) and its main determinants, real income (GDP) and interest rate in Cote d'Ivoire. In order to investigate long-term relationship among these variables, we use Juselius and Johansen cointegration test with time series data covering the period of 1980-2007. The results show that there is long-term relationship among these variables as well as the linkage between them. Base from this result we found that only real money balances (M_1) has significant long -run economic impact of variations in monetary policy in Cote d'Ivoire. However, the study also revealed that the effect of aggregate (M_2) is not so stable linking with it determinants.

Keywords: Cointegration test, Money demand (M_1).

1. Introduction

The research about long-run relationship among broad money and its determinants and the macroeconomic stability have always been a key point of the monetary policy and it has reached exchange rate due to financial innovations, and shift increased financial integration sector. After Friedman's work on the demand for money (Friedman, 1956), many researchers and policy makers are agree that a stable money demand fonction is very important for the central bank's monetary policy to reach it preferable objectives. In an other words , money supply will have a predicable effect on real variables only if when demand for money is stable. The study of long -run relationship between broad money and its determinants and the stability of the demand for money have always been the main points of the monetary policy makers. Knowing that monetary policy depends ceteris paribus, on it short and long- run stability, economist researchers analyze deeply and estimate money demand function at least for two reasons. i) Money demand function's income elasticity tells us the long-term consistent rate of monetary expansion and; ii) Knowing the interest elasticity of money demand allows economists to calculate the welfare cost of long-term inflation see (Baharumshah, 2009) More recently, numerous studies have investigated whether there is a stable relationship money supply and its determinants such as interest rate ,real income(GDP) using a variety of theoretical , empirical and econometric techniques in emerging countries including sub-Saharan African countries. Economist such us (Hafer, 1991) and (Jansen, 1991) , (Miller, 1991), (Hoffman, 1995) and (Rasche, 1992.) investigate the stability of the demand for money in the United States by using either the Engle-Granger two-step cointegration method (Engel -G. , 1987) or the (Johansen S. , 1988) and (Juselius ,. K., 1988) multivariate cointegration method see (Hwan, 2002). In addition, numerous studies have attracted many researchers related to issues in money demand function in Sub Saharan African developing countries has in fact been limited; the exceptions include (Nachega, 2001), (Pedroni, 2004), (Rother P. , 1999), (Jenkins, 1999) and (Shigeyuki, 1988).

The evidence in the studies mentioned above finds that there is strong long-term relationship between income and real balances (Chen, 1997) and (Arize M. a., 2000). Hence it also indicates that the definition of broad money gives better measure to implement policy hence, there is cointegration vector between real income with interest rate while the definition of M_1does not produce any meaningful impact (case of developed countries). However, the empirical studies on the stability of the money demand function in the Sub-Saharan African region confirmed the cointegrating relationship of money demand by the authorities (central banks) promises to play an important role in stabilizing the price levels in this region (Shigeyuki, 1988) and (Loomis, 2006). The studies revealed that both monetary aggregate M_1 and M_2 are reliable variables. In other words, there is a close relationship between the money supply and the real economy over the long-term. Concerning this study we forecast to one important Sub-Saharan African countries which is Cote d'Ivoire .Why Cote d'Ivoire? One of the wealthiest members of French West African country, Cote d'Ivoire enjoyed a high economic growth rate from its independence through the 1970s. Economic productivity and exports subsequently grew with the introduction of a market economy and International Monetary Fund sponsored reforms, but since the late 1990s ethnic and political unrest have hurt the economy. This seriously disrupted the administration and the economic system. Despite the political crisis that has been ongoing since 2002, Côte d'Ivoire's economy nonetheless registered growth estimated at 1.2 per cent in 2006, following a 1.8 per cent increase in 2005 see (African Economic Outlook 2007). We think that the economic growth and macroeconomic stability attempting was not possible without appropriate monetary policy targeting inflation in order to stabilize the economy. The purpose of this paper is to examine the performance of money supply or in another words to determine whether M_1 or M_2 monetary aggregates have any long-run relationships in Cote d'Ivoire using Johansen and juseluis (1990) cointegration approach with its determinants. More specifically, our objective is to examine whether there is a long-run stationary relationship between money demand (M_1or M_2) and its determinants (interest rate, real income GDP) for the period covering 1980-2007. After the monetary adjustment in 1994(devaluation) following by the harmonization of financial instrument in UEMOA (Union Economic Monetaire Ouest-Africain) market the central bank BCEAO (Banque Centrale des Etats de l'Afrique de l'Ouest) authorities have token more responsibility to play role with appropriate monetary policy.

With more than forty years of the literature on monetary areas to consider, the remains part of our study is organize as follows. The next sections involve the empirical foundation of the money demand function. Then, we briefly highlight the econometric methodology and the selected sources in section 3. The section 4 deals with interpretation and discussion of the econometric results of money demand function and the last section is a concluding part that presents recommendations and formulates policies which could help state government and authorities to reach optimal stabilization.

2. The money demand function

In the seminal paper of (Friedman M. , 1959) which has been published in the Journal of Political Economy in 1959, was one of the first theoretical and empirical studies of money demand function. Following this literature there are various theories on the money demand function. For example, (Laidler E. D., 1993) (Kimbrough, (1986b); (Mankiw, November 1986) and (Faig, 1988) set up forth the following demand function by taking account the transaction costs as follow:

$$\frac{M_t}{P_t} = L(Y_t\,, R_t) \quad L_y > 0; R_r < 0 \tag{1}$$

Through the above formula M_t denotes nominal money supply for period t ; P_t represents the price index for period t ; Y_t is the real output for period t ; and R_t represents the nominal interest rate for period *t.* Increases in output yield increases in money demand, and increases in interest rates lead to decreases in money demand. We will however follow the standard method of using national income as the scale variable of choice. As illustrated above, the model estimates elasticity then, we incorporate natural logarithm which produces a more responsive measure of money demand function in Cote d'Ivoire. Hence, we can rewrite the equation as follow:

$$\left(\frac{\mathrm{M}}{\mathrm{P}}\right)^{\mathrm{d}} = f(y, r) \tag{2}$$

M/*P* denotes the real money stock, *y* is represented by real income (GDP/CPI), and *r* indicates the nominal interest rate. Taking natural logarithm (Ln) both sides excepted interest rate, we obtain the following equation:

$$Ln(M - P)t = \theta_0 + \theta_1 Ln(Y) + \theta_2 r + \mu_t \tag{3}$$

The model's parameters θ evaluates the sensitivity of the variables to money demand and μ_t represents a stochastic error term thus, according the equation (3) mentioned above, we expected to have $\theta_1 > 0, \theta_2 < 0$ .Because we want to examine whether real money balances measured by M_1 or M_2 which is more preferable in considering the long-run economic impacts of changes in monetary policy, we use and estimate two models with either scale variable and determine which of the two variables produces a more responsive measure of the money demand function with respect to Cote d'Ivoire.

Model 1: $Ln(M_1 - P)t = \theta_0 + \theta_1 Ln(Y_t) + \theta_2 r + \mu_t$ (4)

Model 2: $Ln(M_2 - P)t = \theta_0 + \theta_1 Ln(Y_t) + \theta_2 r + \mu_t$ (5)

The key point here is that if there really genuine long-run relationship between these three variables equation (3) then, although the variables will rise over time (because they are trended), there will be a common trend that link them together. For an equilibrium, or long run relationship to exist, what we require, the residual term needs to be stationary $\hat{\mu}_t \sim I(0)$. Modern time series analysis has established that regression with non-stationary variables may lead to nonsense regression results (Hendry, 1983) and (Juselius K. , 2000).These regression results might indicate the existence of extremely high correlation between variables; therefore there is no ready causal explanation. The recent development of unit root in econometrics has facilitated addressing the problem in a more constructive way; furthermore details will be given in the coming section.

3. Data and econometric framework.

Data used for the study was obtained from the International Monetary Fund's Financial Statistics (IMF-FS-CDROM) for Cote d'Ivoire (IMF 2008) and all series are seasonally unadjusted. The data for each variable is annual time series data from 1980 to 2007 spanning 28 years and providing a fairly ideal sample size. As explained earlier we have obtained real money balances by divided M_1 and M_2 to consumer price index (CPI) respectively reflecting demand for real money balance (Laidler E. D., 1993).The real income level (GDP/CPI) is obtained directly in World Development Indicators(WDI) data base for the period covering 1980-2007 published by the World Bank . The interest rate we utilize is the market discount rate instead of nominal interest rate because it's only the rate available in IMF data base.

Prior to testing for cointegration, the time series properties of the variables need to be examines. Non-stationary time series data has often been regarded as a problem in empirical analysis. Working with non-stationary variables leads to spurious regression results from which further inference is meaningless when these variables are estimates in their levels. In order to overcome this problem there is a need for testing the stationarity of these micro-economic variables. The unit root and cointegration test on relevant economic variables are in order to determine time series characteristics. This test is important as it shows the number of times the variable has to be differenced to arrive at a stationary value. In general, economic variables which are stationary are called I (0) series and those which are to be differenced once in order to achieve a stationary value are called I (1) series. In testing for stationarity, the standard augmented Dickey-Fuller test (Dickey F. , 1979), (Fuller, 1979) and (Phillips–Perron, 1988) are performed to test the existence of unit root in order to establish the properties of individual series. The regression is estimated by equation (5) as follow:

$\Delta Y_{t-1} = \alpha + \beta Y_{t-1} \sum_{j=1}^{k} \gamma i \, \Delta Y_{t-k} + \varepsilon_t$ (5)

Where Δ is the difference operator, Y the series to being tested, k is the number of lagged differencies, and ε an error term. Beyond testing for the unit root, there is a need to establish whether the non-stationary variables are cointegrated so we follow method developed by (Johansen S. , 1988) and (Juselius K. , 1990) to test for the presence of equilibrium relationship between economic variables. The concept of cointegration implies that, if there is a long run relationship between two or more non-stationary variables. Cointegration test is conducted after conducting a unit root test first on individual series and if the variables are integrated of order one; that is, I (1), the static model is estimated for cointegration regression. Secondly, the order of integration is evaluated, that is on the residual generated from static model. The t-statistics of the coefficient of the regression usingADF test determines whether we should accept cointegration or not. With this cointegration test still error correction is better than and being adopted. Following this procedure, the Error Correction Model (ECM)is very crucial in the cointegration literature as it drives from the fact that, if macro variables are integrated in order one and are cointegrated, they can be modeled as having been generated by Error Correction Model. The error correction model produces better short run forecasts that hold together in economic meaningful ways. Thus, we suggest the reparametrization of the initial vector auto regression (VAR) in the familiar vector error- correction ($VECM$) formulated in equation (6). The general $VAR(p)$ model can be written as:

$$\Delta Y_t = \prod Y_{t-p} + \sum_{i=1}^{p-1} \prod i\, \Delta_{t-1} + \emptyset B_t + v_t \tag{6}$$

Where Y_t is and $NX1$ vector of the time series of interest, $v_t \sim IN(0, \sum)$, and B_t contains the conditioning variable set. The order of VAR p is assume finite and the parameters$\prod_i$, $\prod$ and $\emptyset$ are assume constant. The long-run response matrix is $\prod$and, if the case $\prod$ can be express as the product of two Nr matrixes φ and $\omega's$: $\prod$=$\varphi\omega$ where ω contains the r cointegrating vectors and φ is the loading matrix which contains the coefficients with which the cointegrating relationships enter the equations ΔY_t .As we mentioned earlier Johansen and Juselius methodology target is to test the existence of the long-run equilibrium relationship among the variables therefore the test is base on the maximum eigenvalue noted by (λ_{max}) including the trace statistic (λ_{trace}) or the likelihood ratio $(L.R)$.The general overparameterized model is estimated with maximum n lags denoted p. An error correction term is introduced in the model. Hence equation (7) is re-specified to include error-correction term (ECT) in this form:

$$\Delta Ln(M-P)t = \sum_{k=1}^{n} \mu' \, \Delta Ln(M-P) + \varphi[Ln(M-P)t - 1 - \omega' F_{t-1}] + \sum_{p=0}^{n} \Upsilon' \, \Delta F_{t-k} + \mu_t \tag{7}$$

Where $F = [Y_t, r]'$ is the vector of fundamentals and μ_t is independently an identically distributed (i.i.d) mean-zero stationary random variable. The formula $[Ln(M-P)_{t-1} - \omega' F_{t-1}]$ measure the adjustment speed between the short-run and long-run disequilibrium and is vector error correction term (ECT) as independent variable in the estimation process will cover all the long-run information that was lost in the original estimation process.

4. Empirical results and interpretation.

4.1. Empirical results.

In this section, we first perform the augmented Dickey-Fuller (DF) and Phillips–Perron (1995) test, which tests the series's stationarity. In all cases, the test concerns whether $\gamma = 0$ equation (5).The ADF statistic is the t statistic for the lagged dependant variable. If the ADF statistical value is smaller than the critical value then we reject the null hypothesis of a unit roots and conclude that Y_t is a stationary process. However the result is presented in table 1. the standard augmented Dickey-Fuller test (Dickey F. , 1979), (Fuller, 1979) and (Phillips–Perron, 1988) which test the stationarity of the individual variables shows that we fail to reject the stationary null hypothesis base on ADF and PP tests at level. In another words the tests indicate that all variables contains a unit root at level while they are all first difference stationary equation (5).Thus, according the empirical foundation, we found that all variables follow the $I(1)$ process.

The second test conducted is the cointegration tests following the famous method of (Johansen S. , 1988) and (Juselius K. , 1990). As we illustrate earlier this method is based on the statistics values such us maximum eigenvalue (λ_{max}) the trace statistics (λ_{trace})or the likelihood ratio (LR).We use these two statistics value to find the number of cointegration vectors between money supply and it determinants. It necessary for us to determine the appropriate lag length (k) before the cointegration tests is conducted. We use the criteria developed by using the Akaike Information criterion (AIC) and Schwarz Bayesian Criterion (SBC) in this form:

$$AIC(p) = Ln\left(\frac{SSR(p)}{p}\right) + (p+1)\frac{2}{T} \tag{8}$$

$$BIC(p) = Ln\left(\frac{SSR(p)}{T}\right) + (p+1)\frac{LnT}{T} \tag{9}$$

Where $SSR(p)$ is the sum of square residuals of the estimated $AR(p)$ the BIC estimator of $\widehat{p}$,p is the value that minimizes $BIC(p)$among the possible choices $p = 0,1 \dots, p_{max}$ is the largest value of p value considered. Because the regression decreases when add lag. In contrast, the second term increases when you add a lag. The BIC trades off these two forces so that the number of lag that minimizes the BIC is a constant estimator of the true lag length (Waston, 1994).The difference between the AIC and the BIC is that the term "LnT" in the BIC is replace by "2" in the AIC, so the second in the AIC is smaller then T represent the simple. The result shows that the optimal lag length is $k = 6$ respectively for model 1 and model 2.

Thirdly, we determined the number of cointegrating vectors for different combinations of variables. For that, we forecast on the degree of adjusted version of the λ-max and trace statistics since the Johansen procedure tends to overestimate the number of vectors with small samples and or too many variables (Cheung and Lai, 1993) the result is shown in table 2 and 3 bellow. And finally, after obtaining the long-run cointegration relationships using Johansen method, the short-run dynamics of the long-run money demand model is explored by estimating an error correction model with maximum six (6) lag assuming the unrestricted intercepts procedure with no trend in the VAR model as follow:

$$\Delta Y_t = \gamma_1 Y_{t-1} + \cdots + \gamma_k \Delta Y_{t-k+1} + ECM_{t-1} + \Phi D_t + \epsilon_t \qquad (10)$$

Where ECM_{t-1} is one lag of error-correction term and D_t incorporates dummies and intercept. Following the literature, we can get the cointegrating relationship which is normalized against real money balance. The error-correction term (ECT) coefficient term is estimate of back adjustment speed to the long-run equilibrium relationship. The ECT should have a negative sign and significantly different from zero. The negative sign of ECT means that the deviation event between actual and long-run equilibrium level would be adjusted back to the long-run relationship in the current periods to clear this discrepancy. Since all the variables in the above model follow $I(1)$ process, statistical inference base on standard t and $F - tests$ is valid. Thus we can find the preferred model by removing all parsimonious insignificant regressors and test whether this diminution is supported by$F - test$. In our present case, because we want to examine whether real money balances measured by M_1 are preferable to those measured by M_2 in considering the long-run economic impacts of changes in monetary policy, we estimate separately ECM for model 1 equation (4) and model 2 equation (5) are presented in table 4 and 5. (We don't display these 2 tables in our work because space problem but available by the author upon the request). Hence, by using the AIC and the BIC criterion we find that the maximum lag length for both models is $k = 6$. Finally, the resultant model can be checked by performing diagnostic tests on the residuals.

In the same order we examine the presence of autocorrelation in the error terms of a regression models. (Engel F. R., 1982) introduced a new concept allowing the autocorrelation to occur in the variance of the error, rather than in the error themselves. To capture this autocorrelation Engel developed the Autoregressive Conditional Heteroskedasticity ($ARCH$) model, the key idea behind which is that the variance of μ_t depend on the size of square error them lagged one period that is μ_{t-1}^2 . Table 6 shows the parsimonious equation and diagnostic test results with M_1 and M_2 .The diagnostic tests refer to the first and fourth autoregressive conditional heteroskedasticity test ($ARCH$) ,the general heteroskedasticity test (White) and the Lagrange multiplier test (LM) developed by (Breusch, 1979) and (Godfrey, 1979) .

4.2. Interpretation of empirical results.

We first examine the money demand function with for both models 1and 2. For this analysis, we conducted the standard augmented Dickey-Fuller test (Dickey F. , 1979), (Fuller, 1979) and (Phillips–Perron, 1988) for all variables simultaneously (M_1, M_2 Y and r) to test whether each variable taking individually was stationary or not. The result shown in table 1 fail to reject the null hypothesis at level based on the tests mentioned above. But the overall tests shows that all the variables are stationary at first difference and treated as $I(1)$ process according the literature.

The second stage was to perform the cointegration test using the popular method developed by (Johansen S. , 1988) and (Juselius K. , 1990). We found in the preliminary analysis that real money($M_1 - P$) real income(Y) and interest rate r are cointegrated at the 5% level of significance. Both the LR tests identify a unique statistically significance vector with ($\lambda_{max} = 0.681539, \lambda_{trace} = 38.80344$) see table 2. However, we reject the null hypothesis that long-term relationship exist between aggregate M_1 and it determinants (model 1) when the nominal interest rate is employed as the opportunity cost of holding money. Meanwhile, the L. R statistics for real money demand ($M_1 - P$), real income, are not all statistically significant at conventional significance levels even at 10% compare to the model 2 which real income and the nominal interest rate is significant at 10% level. The estimated cointegrating vectors are giving economic meaning by the normalized equation on money balances. Normalization is only conducted if nonzero vector or vectors are confirmed by the cointegration test. Table 2 shows the results of the normalized cointegrating vector tests for Model 1and 2. The normalized equation with ($M_1 - P$)indicates more meaningful result with real income elasticity (5.311675) significantly greater than the zero and negative sign of nominal interest rate elasticity (0.191327). As is evident from Table 2, the normalized equation with ($M_2 - P$) model 2 shows less meaningful result and the real income elasticity (1.438495) is greater than zero but positive sign of nominal interest rate elasticity (0.045515).Thus, as we mentioned earlier, if we utilize the nominal interest rate, regarding aggregate M_1 or M_2 we fail to reject the null hypothesis of single cointegration at 5% significance level. This mean that the money demands function in Cote d'Ivoire is stable. Therefore, the long-run nominal interest rate used for our study seems to be acceptable in specifying the money demand function. As suggested Jansen ,Thornton and (Dickey, 1991), the vector that makes economic sense is that the estimated coefficients are close to and have the same signs as those predicted by economic theory. However, according to Jansen, Thornton and Dickey (1991), cointegration analysis does not give estimates with structural interpretation regarding the magnitude of the parameters of the cointegrating vectors. Because cointegrating vectors merely imply long run, stable relationships among jointly endogenous variables, they generally cannot be interpreted as structural equations. All that can be said is that there are a number of linear combinations for which the variance is closed. In this way we cannot decide whether real money balances measures by M_1 or M_2 produces a plausible response for money demand function in Cote d'Ivoire.

Third, after computing the long-run cointegration relationships using the Johansen method, the short-run dynamics of the long-run money demand function is analyzed by computing an error-correction model(ECM). The selection of the number of lags($k = 6$) for model 1 and 2 included in the estimated model was based on the famous general methodology. The results are summarized in tables (4 and 5). We found that only money demand function running by model 1 equation (4) displays a correct sign (negative) and relatively small $ECT1_{t-1}$ coefficient (0.0044). This implies that the adjustment process to an exogenous shock is rather slow. The $ECT1_{t-1}$ coefficient (-0.0044) means that it would take 0.44 of the year of real money balances M_1 to come to equilibrium if an econometric shock of money aggregate M_1 occurred in the exogenous on the right hand side. However, (Deng and Liu, 1999) reported a value of -0.12 for the error-correction term for M_2 using data from 1980:1 to 1994:4. Therefore, cointegration among M_1 and its determinants can also be confirmed by the significance of the lagged error–correction term. Furthermore, the test indicates that the nominal interest rate seems not to be an important component for long-run cointegration estimation vector but has a significant short-run impact on money demand.

Fourth, we continued our study by testing the model 1 and 2 utilizing a battery of diagnostic tests. For that we conducted the autoregressive conditional heteroscedasticity test (ARCH), the general heteroscedasticity test (White) and the Lagrange multiplier test (LM) developed by (Breusch, 1979) and (Godfrey, 1979) .Table 6 shows the parsimonious equations and diagnostic test results with both models 1 and 2 .The computed Breusch–Godfrey Lagrange multiplier (LM) statistic shows no evidence of serial correlation up to the fourth order in the VAR residuals with aggregate M_1 then aggregate M_2 see table 6 respectively panel A and B. The Ramsey's RESET (Ramsey, 1969) statistics revealed no serious misspecification of variables. Both models also passed the (Jarque-Bera, 1987) test for normality without any serious pain. The coefficient of the error-correction term is positive and statistically insignificant for aggregate M_2, this is theoretically implausible because it means that the demand for money is not so stable when M_2 is utilized as monetary aggregate. In contrary, the diagnostic statistics test with aggregate M_1 are satisfactory and pass the standard tests with negative error-correction term coefficient. The small magnitude of the coefficient suggests that the speed of adjusting to long-run changes is slow therefore acceptable as we explained earlier. This means that the money demand with aggregate M_1 is more stable. In order to verify the stability of our models coefficients, we performed the $CUSUM$ and $CUSUMQ$ square (Brown and Durbin, 1975) to test the parameters stability of the money demand function. Figure 2 and 3 display the cumulative sum of residuals plot. We found that only the money demand functions with aggregate M_1 (model 1) appears more stable at 5 percent level of significance than model 2 using aggregateM_2. Therefore following the literature, we partially conclude that the real money balances measured by M_1 are preferable to those measured by M_2 in considering the long-run economic impacts of changes in monetary policy in Cote d'Ivoire.

5. Conclusion

The main objective of this paper was to analyze the money demand function in Cote d'Ivoire using the recently advanced method cointegration test utlizing time series data covering the period of 1980-2007. The software Eviews 3.1 was utilized for our econometric analysis. Unit root test was conducted to test the stationarity of data and cointegration test was performed to test for the existence of the long-run relationships of the variables. In the same way, the models 1 and 2 were generated from overparameterized models, based on statiscall rather economic considerations. We also run a battery of diagnostic tests such as $ARCH$, White, LM and Ramset RESET. Finally, according the importance of the stability in the regression analysis of the model, we run the stability test to check whether our models were stable at the conventional significance level. Basing on theoretical and related empirical literature from Sub-Saharan Africa and other related studies, a number of hypotheses were tested. Following the leaving out of insignificant variables in the general model without losing valuable information, the models 1 and 2 pass the misspecification and serial correlation test and reports significant $F - statistcs$ implying that there is an improvement in the overall significance of the models.The empirical analysis results revealed that there exists a cointegration relation between money demand and it determinants in Cote d'Ivoire for the period covering 1980-2007, whatever M_1 or M_2 is used as the money supply measure. The econometric results shows that money supply using aggregate $M_1$is more reliable and gives plausible response in term of policy variables in order to target inflation and the opportunity cost of holding money this according our empirical evidence.

The results also highlight the evidence of some important policy implications. Our empirical results suggest that monetary policy or money supply (M_1) is a reliable policy variable aimed at stabilizing the domestic economy by targeting inflation at the same time promoting economic growth. As expected, national income positively influences the level of money demanded in the economy whereas nominal rates negatively impact money demand. This confirms our empirical finding. Thus, due to the existence of an equilibrium relationship between real money balances, real income, and price level, in attempting to control the price level or output, the reliability of money supply as a target variable holds (Shigeyuki, 1988) and (Loomis, 2006). Therefore, the results of this study could be useful for Cote d'Ivoire policy makers and monetary authorities in making appropriate fiscal and monetary policies.

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Table 1: Univariate unit root tests.

Test/variables	ADF statistics No trend	ADF statistics Trend	Phillips-Perron Statistics No trend	Phillips-Perron Statistics Trend
Level				
Ln(M1-P)	0.614323	-2.15013	0.915187	-2.38644
Ln(M2-P)	0.231298	-1.7547	0.260894	-1.95193
LnY	0.506304	-2.075838	0.491382	-1.78201
r	-1.8308***	-2.81233	-1.12197	-3.1031
First difference				
ΔLn(M1-P)	-3.903757*	-3.78718*	-4.26774*	-4.11359*
ΔLn(M2-P)	-4.043563*	-4.1018**	-5.6289*	-5.72846*
ΔLn(Y)	-2.59947**	-2.598441	-3.1731**	-3.0951*
Δr	-3.89932*	-4.2932*	-5.19810*	-5.4145*

Source: Own computation by Eviews 3.1

The table shows univariate unit root tests. The notation $(M1-P), (M2-P), Y$ and r indicate respectively the real money supply, national real income and nominal interest rate. The Δ denotes first-difference derivation. The asterisks *, **, and *** denote statistical significance at 1%, 5%, and 10% levels, respectively. McKinnon (1980) critical values are used for rejection of the null unit root.

Table 2: Johansen tests for cointegration with monetary Aggregate M_1.Series: $Ln(M_1-P)$,LnY, r

λ_{max} Eigenvalue	Likelihood Ratio L.R	5 % CV	1% CV	Hypothesized No. of CE(s)
0.681539	38.80344	29.68	35.65	None **
0.416396	12.48554	15.41	20.04	At most 1
0.004308	0.099297	3.76	6.65	At most 2

This table displays Johansen tests for cointegration. The asterisks *, **,denote statistical significance at 1%, 5%, level, respectively. The λ-max and λ-trace (LR) are Johansen's maximum eigenvalue and trace eigenvalue statistics for testing cointegration. Critical values ($C.V.$) L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

Ln(M1-P)	*LnY*	*r*	*C*
1	5.311675	0.191327	-25.29941
	-6.16372	-0.24307	
Log likelihood	58.92131		

Table 3: Johansen tests for cointegration with monetary Aggregate M_2.Variables Ln (M_2-P), LnY, r

λ_{max} Eigenvalue	Likelihood Ratio L.R	5% C.V	1% C.V	Hypothesized No. of CE(s)
0.732478	53.92407	29.68	35.65	None **
0.416883	23.59734	15.41	20.04	At most 1 **
0.38529	11.19189	3.76	6.65	At most 2 **

This table displays Johansen tests for cointegration. The asterisks *, and**, denote statistical significance at 1%, and5% level, respectively. The λ-max and λ-trace(L.R) are Johansen's maximum eigenvalue and trace eigenvalue statistics for testing cointegration. Critical values ($C.V.$) *(**) denotes rejection of the hypothesis at 5%(1%) significance level, L.R. test indicates 3 cointegrating equation(s) at 5% significance level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

Ln(M2-P)	*LnY*	*r*	*C*
1	-1.438495	-0.045515	3.974909
	-0.078	-0.00438	
Log likelihood	44.58638		

Table 6: Error -Correction Regression
Panel A Aggregate: M_1

$$
\begin{aligned}
\Delta DLnM1_{t-1} = {} & -0.2780 + 0.4912DLnY_{t-1} - 1.2057DLnY_{t-2} + 09485LnDY_{t-3} - 0.6591\mathrm{DLnY}_{t-4} \\
& - 0.1049\mathrm{DLnY}_{t-5} + 0.0320\mathrm{DLnY}_{t-6} + 0.0151Dr_{t-1} - 0.0036Dr_{t-2} \\
& - 0.02\mathrm{Dr}_{t-3} + 0.0311\mathrm{Dr}_{t-4} - 0.0013\mathrm{Dr}_{t-5} + 0.0128\mathrm{Dr}_{t-6} - 0.0044\mathrm{ECM}_{t-1}
\end{aligned}
$$

LM(1):	1.6951	ARCH(1):	0.2146	R^2:	0.6008	D.W.:	2.1616
LM(2):	1.478	ARCH(2):	0.1733	$\bar{R}$:	0.1405	WHITE:	2.0477(0.1210)**
LM(3):	0.7927	ARCH(3):	0.0468	SE:	0.0763	Jarque-Bera	1.0549(0.5901)**
LM(4):	1.2844	ARCH(4):	0.0503	F-statistic:	0.81043(0.64769)**	Reset:	1.1795(0.4645)**

Notice: Numbers in parentheses are $t - values$. R^2 Is the $R - square$, Adjusted $\bar{R}$ is the adjusted coefficient of determination. DW is the Durbin-Watson statistic, which tests the autocorrelation. LM (p) is the Lagrange multiplier test statistic for up to the fourth-order autocorrelation. ARCH (p) is a test statistic for up to the fourth-order autoregressive conditional heteroskedasticity. WHITE indicates White's (1980). The asterisks (**) denotes the corresponding probability's value.

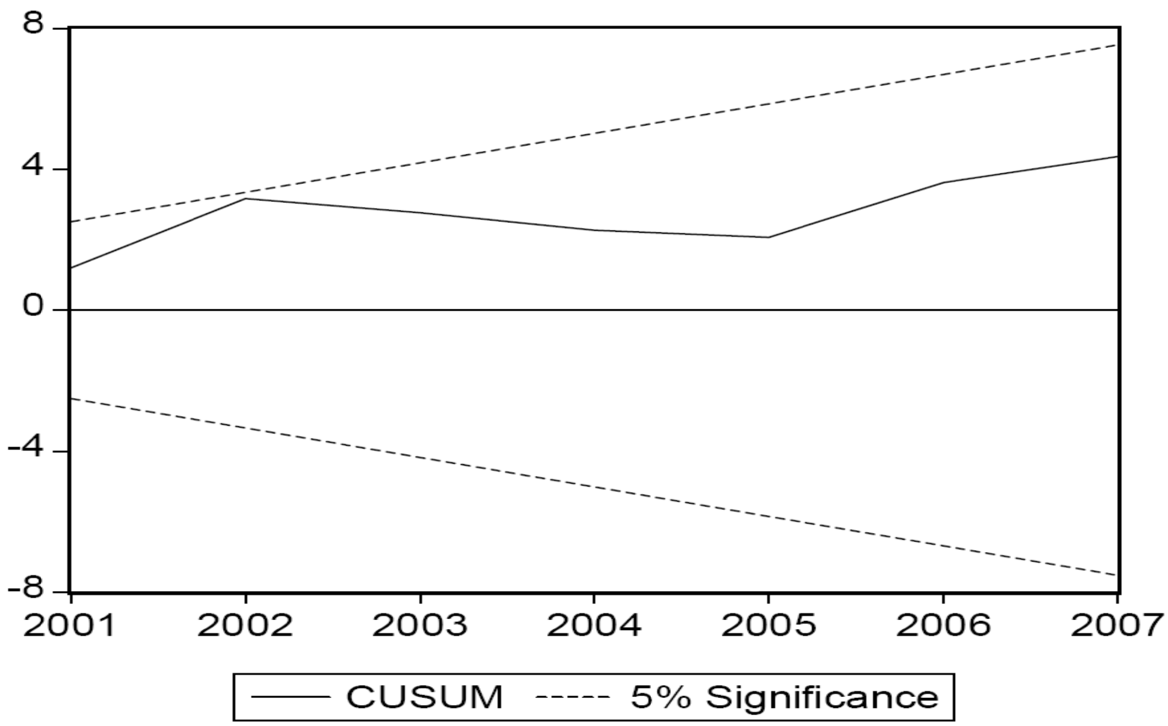
Panel B Aggregate: M_2

$$DLnM2 = 0.2472 + 2.8164DlnY_{t-1} - 2.9214DlnY_{t-2} + 3.1466DLnY_{t-3} - 1.9998\,DLnY_{t-4} + 1.8254DLnY_{t-5} - 0.7257DLnY_{t-6} + 0.0563Dr_{t-1} + 0.0575Dr_{t-2} + 0.0064Dr_{t-3} + 0.0813Dr_{t-4} - 0.0379Dr_{t-5} + 0.0784Dr_{t-6} + 0.00302ECM_{t-1}$$

LM(1):	2.4443	ARCH(1):	0.5696	R^2:	0.5026	D.W.	2.8215
LM(2):	2.1776	ARCH(2):	0.0952	$\bar{R}$:	0.4213	WHITE	0.8314(0.5190)**
LM(3):	2.2119	ARCH(3):	0.1879	SE:	0.1854	Jarque-Bera	2.0222(0.3638)**
LM(4):	1.8623	ARCH(4):	1.3075	F-statistic:	0.544(0.8371)**	Reset	0.6991(0.6418)**

Notice: Numbers in parentheses are $t - values$. R^2 Is the $R - square$, Adjusted$\bar{R}$: is the adjusted coefficient of determination. DW is the Durbin-Watson statistic, which tests the autocorrelation. LM (p) is the Lagrange multiplier test statistic for up to the fourth-order autocorrelation. ARCH (p) is a test statistic for up to the fourth-order autoregressive conditional heteroskedasticity. WHITE indicates White's (1980). The asterisks (**) denote the corresponding probability's value.

Figure 1. Plot of Cumulative Sum of Squares of Recursive Residuals for Aggregate M1.



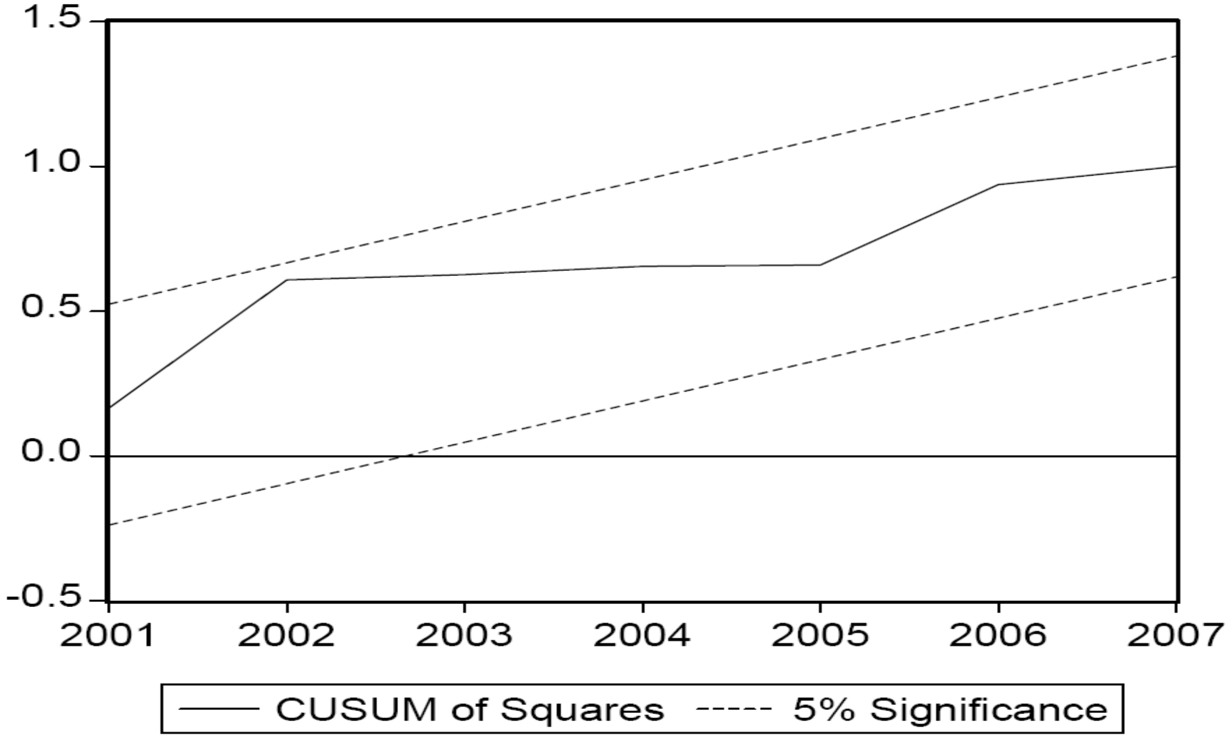
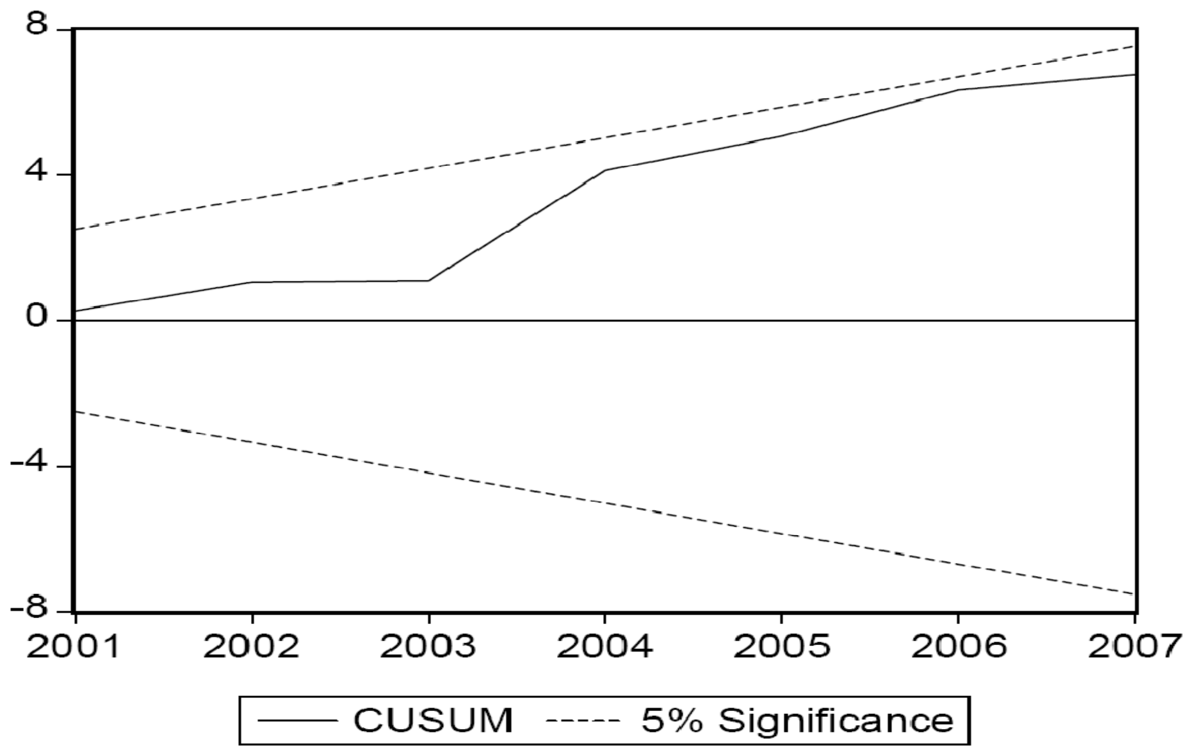
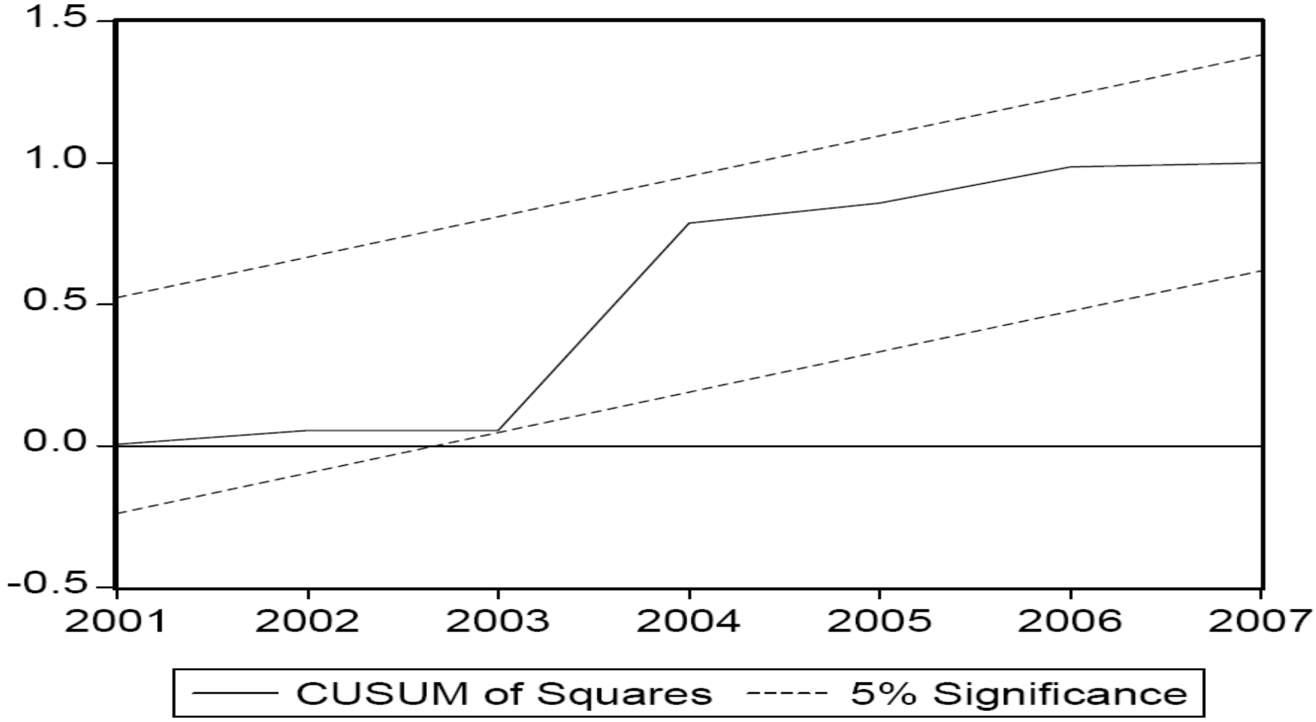


Figure 2. Plot of Cumulative Sum of Squares of Recursive Residuals for Aggregate M2




1.5
1.0
0.5
0.0
-0.5
2001
2002
2003
2004
2005
2006
2007
CUSUM of Squares
5% Significance